Performance Evaluation of ad-hoc Network Routing Protocols using ns2 Simulation

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Abstract —**Ad-hoc networks are basically peer to peer multi-hop mobile wireless networks in which the information packets are transmitted in a 'store and forward' manner from a source to an arbitrary destination via intermediate nodes. The main objective of this paper is to evaluate the performance of various ad-hoc networks routing protocols viz. DSDV (Destination Sequence Distance Vector), DSR (Dynamic Source Routing) and AODV (Ad-hoc On Demand Distance Vector). The comparison of these protocols is based on different performance metrics, which are throughput, packet delivery ratio, routing overheads, packet drop and average end to end delay. The performance evaluation has been done by using simulation tool NS2 (Network Simulator) which is the main simulator.**

Index Term- Destination Sequence Distance Vector (DSDV), Dynamic Source Routing (DSR), Ad-hoc On Demand Distance Vector (AODV), Network Simulator (NS2)

I. Introduction

Wireless networking is an emerging technology that allows user to access information and services electronically, regardless of their geographic position. The Wireless networks are classified as infrastructure networks and infrastructure less (ad-hoc) networks. Infrastructure networks consist of fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its Communicate radius. The mobile unit can move geographically while it is communicating. When it goes out of Range of one base station, it connects with new base station and start communicating through it. This is called handoff. In this approach the base station are fixed [1]. Infrastructures less or Ad-hoc networks are basically self organizing and self configuring multi-hop mobile wireless networks where the structure of the network changes dynamically. This is mainly due to the mobility of nodes [2]. Nodes in this network utilize the same random access wireless channel cooperating in friendly manner to engaging themselves in multi-hop forwarding. The node in this network not only acts as hosts but also as routers that route data to and from other nodes in the network [3].Therefore communication between mobile nodes always requires routing over multi-hop paths. In this paper an attempt has been made to evaluate the performance of three well known routing protocols DSDV, AODV and DSR on the basis of different performance metrics. Apart from that with the increase of portable of devices as well as progress in wireless communication, Ad-hoc network gaining importance with the increasing number of widespread application. The following point shows the importance of ad hoc networks [5, 6].

Instant Infrastructure: Unplanned meetings, spontaneous interpersonal communications etc., cannot rely on any infrastructure, it needs planning and administration. It would take too long to set up this kind of infrastructure; therefore ad-hoc connectivity has to setup.

Disaster Relief: Infrastructure typically breakdown in disaster area. Hurricanes cut phone and power lines, floods destroy Base stations, fires burn servers. No forward planning can be done, and the set-up must be externally fast and reliable. The same applies to many military activities, which are, to be honest, one of the major driving forces behind mobile ad-hoc networking research.

Effectiveness: Service provided by existing infrastructure might be too expensive for certain applications. If, for example only connection oriented cellular network exist, but an application sends only small status information every other minute, cheaper ad-hoc packet-oriented network might be a better solution. Registration procedure might take too long and communication overheads might be too high with existing networks. Tailored ad- hoc networks can offer a better solution.

Remote Areas: Even if infrastructure could be planned ahead, it is sometimes too expensive to set up an infrastructure in sparsely populated areas. Depending on the communication pattern, so ad-hoc networks or satellite infrastructure can be a solution.

Due to their quick and economically less demanding deployment, this network finds many applications in several areas. Some of these include military applications, collaborative and distributed computing, emergency operations, wireless mesh networks, wireless sensor networks, and hybrid wireless networks etc. Regardless of these attractive applications, ad-hoc networks have many salient features, but these features also introduce several challenges. The major issues that affect the design, deployment and performance of an ad-hoc network wireless system are as follows [5-8]:

Packet losses due to transmission errors: -Mobile ad-hoc network experiences a much higher packet losses due to some factors such as high bit error rate (BER) in the wireless channel, increased collision due to the hidden terminal problem, presence of interference, location dependent contention, unidirectional links, frequent path break due to node mobility

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and the inherent fading property of wires medium [6].
Route changes due to mobility: -The network topology in an ad-hoc wireless network is highly dynamic due to mobility of nodes; hence an on-going session may suffer from frequently path breaking. This session often leads to frequent route changes therefore mobility management itself is very vast research topic in mobile ad-hoc wireless networks [6].
Security issues: -The radio channel is used for ad-hoc wireless network is broadcast in nature and is shared by all the nodes in the network. Data transmitted by a node is received by all the nodes within its direct transmission range. So attacker can easily snoops the data being transmitted by a node in the network. Here the Requirement for confidentiality can be violated if an adversary is able to interpret the data gathered through snooping [7].
Limited wireless transmission range: - In wireless network the radio band will be limited and hence data rates it can offer are much lesser than what a wired network can offer. This requires an optimal manner by keeping the overhead as low as possible [7].
Routing overhead: -in wireless ad hoc networks, nodes often change their location within the network. So stales route are generated in the routing tables which leads to unnecessary routing overheads [8].
Battery constraints: -This is one of the limited resources that form a major constraint for the nodes in ad hoc networks. Devices used in these networks have restriction on the power source in order to maintain portability, size, and weight of the device. [8].
Potentially frequent network partition: - The randomly moving nodes in an ad- hoc can lead to network partition. In major cases the intermediate nodes are the one which are highly affected by this partitioning.

II. CLASSIFICATION OF ROUTING PROTOCOLS

Routing protocols for mobile ad-hoc networks can be broadly classified into two main categories:

A. Table Driven Routing Protocols (Proactive)

Proactive or table-driven routing protocols attempts to maintain consistent and up-to date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store routing information, and they respond to change in network topology by propagating route update throughout the network to maintain consistent network view [9]. Certain proactive routing protocols are Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Global State Routing (GSR) and Cluster-head Gateway Switch Routing (CGSR).

B. On-Demand Routing Protocols (Reactive)

In reactive or on demand routing protocols, the routes are created as when required. When a source wants to send to a destination, it invokes the route discovery mechanism to find the path to the destination. This process is completed when once a source is found or all possible route permutation has been examined. Once a route has been discovered and established, it is maintained by some form of route maintenance procedure until either the destination becomes inaccessible along every path from the source or route is no longer desired [9]. Certain proactive routing protocols are Ad-hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Associatively-Based Routing (ABR), Signal Stability Routing (SSR).

III. Overview of DSDV, AODV and DSR

A. Destination sequence distance vector routing (DSDV)

Destination sequenced distance vector (DSDV) routing protocol is a table driven routing protocol based on the classical Bellman- Ford routing algorithm. The improvement made here is the avoidance of routing loops in a mobile network of routers. Each node in the mobile network maintains a routing table for all possible destinations within the network and the number of hops to each destination node. Each entry is marked with a sequence number and this number is assigned by the destination node.

A sequence numbering system is used to allow mobile hosts to distinguish stale routes from new ones. Routing table updates are periodically transmitted throughout the network in order to maintain table consistency. Large amount of network traffic, route updates can employ in two types of packets they are first is the “Full Dump” and second is the “Incremental routing”. A full dump sends the full routing table to the neighbors and could cover many packets whereas, in an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet. When the network is relatively stable, incremental updates are sent to avoid extra Traffic and full dump are relatively infrequent. In a fast changing network, incremental packets can grow big, so full dumps will be more frequent [10].

B. Ad-hoc On-demand Distance Vector Routing (AODV)

The AODV is a Reactive on- demand “ad-hoc distance vector routing protocol”. AODV is an improvement on DSDV because it typically minimizes the number of required broadcasts by creating routes on demand basis as opposed to maintaining a complete list of routes, as in the DSDV algorithm. When a source node desires to send a message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the destination. In AODV each router maintains route table entries with the destination IP address, destination sequence number, hop count, next hop ID and lifetime [10].

RREQs route requests and RREPs route replies are the two message types defined by the AODV. When a route to a new destination is needed, the node uses a broadcast RREQ to find a route to destination. A route can be determined when the request reaches either the destination itself or an intermediate node with a fresh route to the destination.The route is made available by unicasting a RREP back to the

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source of RREQ. Each node maintains its own broadcast id, sequence number.The broadcast ID is incremented for every RREQ packet. Since each node receiving the request keeps track of a route back to the source of the request, the RREP reply can be unicast back from the destination to the source, or from any intermediate node that is able to satisfy the request back to the source [11].

C. Dynamic Source Routing (DSR)

The dynamic source routing (DSR) protocol is an "on-demand routing protocol" that is based on the concept of source routing. Mobile nodes are required to maintain route caches that contain the source routes of which the mobile is aware. Entries in the route cache are continually updated as new routes are discovered. The protocol consists of two major phases: Route discovery and route maintenance [11].

When a mobile node has a packet to send to some destination, it first consults its route cache to determine whether it already has a route to the destination. If it has an unexpired route to the destination it will use this route to send packets. On the other hand, if the node does not have such a route to the destination it initiates route discovery by broadcasting a route request packet this route request contains the address to the destination along with the source nodes address and a unique identification number. A route reply is generated when the route request reaches either the destination itself, or an intermediate node whose route cache contains an unexpired route to the destination.

Route maintenance is a procedure, which maintains transmission of packets in the routing through the use of route error packets and acknowledgement. Route error generated at a node, when data link layer encounters transmission error. Acknowledgements are used to verify the correct operation of the route link [12].

DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table driven approach. The intermediate nodes also utilize the route cache information efficiently to reduce the control overheads. The disadvantage of DSR is that, the route maintenance mechanism does not locally repair a broken down link. Even though the protocol performs well in static and low mobility environments, the performance degrades rapidly in with increasing mobility.

IV. SIMULATION BASED ANALYSIS

This section described the simulation tool, network topology, Simulation parameters and simulation results. The performances of proactive (DSDV) and reactive (AODV and DSR) routing protocols are evaluated on the basis of five performance metrics mentioned below.

A. Simulation Tool:

In this paper the simulation of AODV, DSDV, and DSR routing protocols is done by using network simulator (NS2) software due to its simplicity and availability. NS is a discrete event Simulator targeted at networking research NS provides substantial support for simulation of TCP, routing and multicast routing protocols over a wired and wireless network.NS2 is written in C++ and OTCL. C++ for data per event packets and OTCL are used for periodic and triggered event [12]. NS2 includes a network animator called nam animator which provides visual view of simulation. NS2 preprocessing provides traffic and topology generation and post processing provide simple trace analysis. AWK programming is used for trace file analysis [13].

B. Performance Metrics:

The following performance metrics are used in this paper for the performance evaluation of AODV, DSDV and DSR Routing protocols.

1) Throughout: - It is the amount of data transferred over the period of time expressed in bits per second or bytes per second.

2) Packet delivery ratio: - It is the ratio of the number of data packets received by the destination node to the number of data packets sent by the source mobile node. It can be evaluated in terms of percentage (%)

3) Routing overheads: - The number of control packets generated by each routing protocols.

4) Packet drop: - The number of data packets that are not successfully sent to the destination.

5) Average end to end delay: - The average time between packet transmission from source node, until packet received at destination.

C. Network Topology and Simulation Parameters:

The following topology and simulation parameters are used in this paper to analyze the performance of proactive (DSDV) and reactive (AODV and DSR) routing protocols as shown in the figure1 and table1.

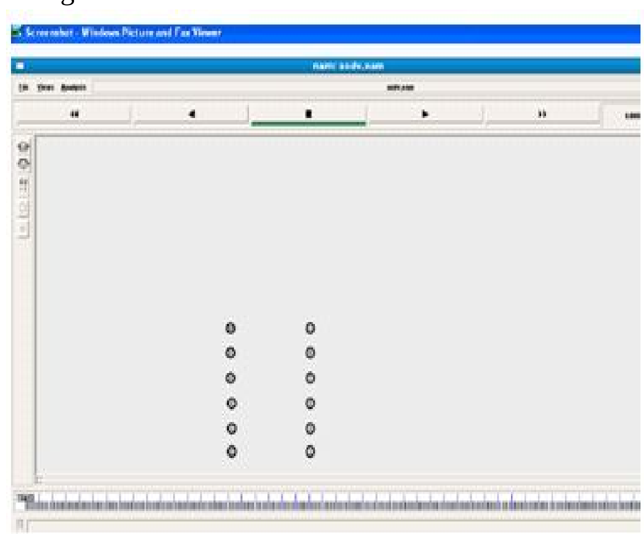

Fig.1 Network Topology

This topology consists of 12 nodes, where first Coolum of six nodes are senders and second column of six nodes are receivers. All the senders start the traffic at different-different time and share the channel bandwidth with other previous transmitting nodes. This topology is generated by the network animator tool, after running TCL script by considering the following simulation parameters table.

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TABLE I. SIMULATION PARAMETERS

Channel	Channel/Wireless
Propagation	Propagation/Tworay ground
Network interface	Phy/Wireless phy
NS version	Ns-allinone-2.31
MAC	Mac/802_11
CBR Packet Size	512 bytes
Interface Queue	Queue/Droptail/Priqueue
Link layer	LL
Antenna	Antenna/Omni Antenna
Interface Queue Length	50
No. of nodes	4,8,12
Simulation area size	700*600
Simulation duration	60 second
Routing Protocols	DSDV, AODV and DSR

D. Simulation Results:

The simulation results are shown in the following section in the form of comparative graphs. In this paper an attempt has been made to compare the performance of three well known routing protocol DSDV, AODV, and DSR according to his simulation results. The simulation results are genrated through the excel graphs according to above mentioned topology and criteria as shown in table.

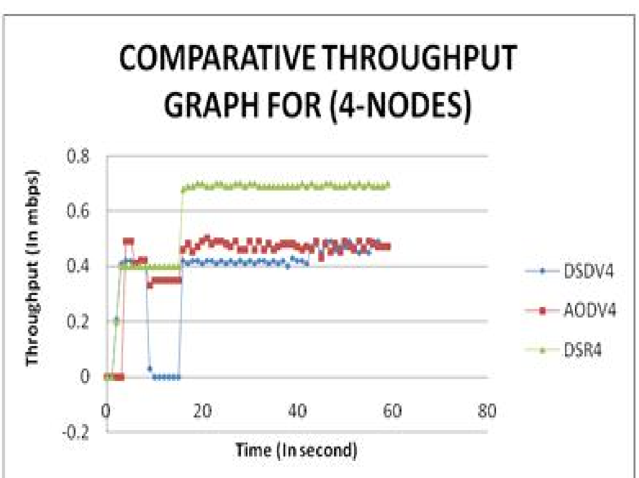

Fig.2. Throughput Comparison for 4-nodes

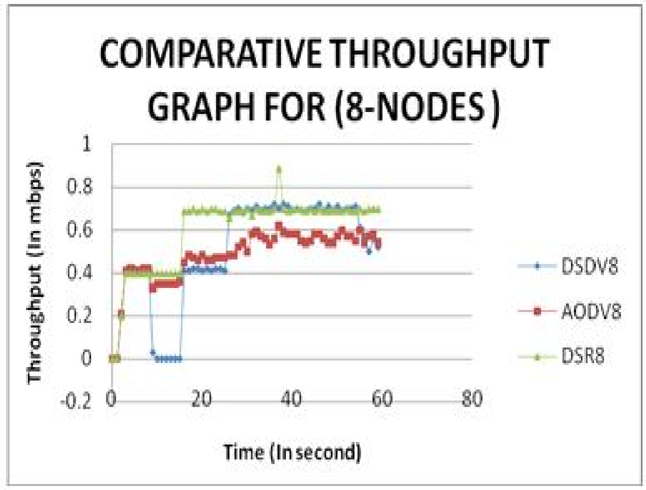

Fig.3. Throughput Comparison for 8-nodes

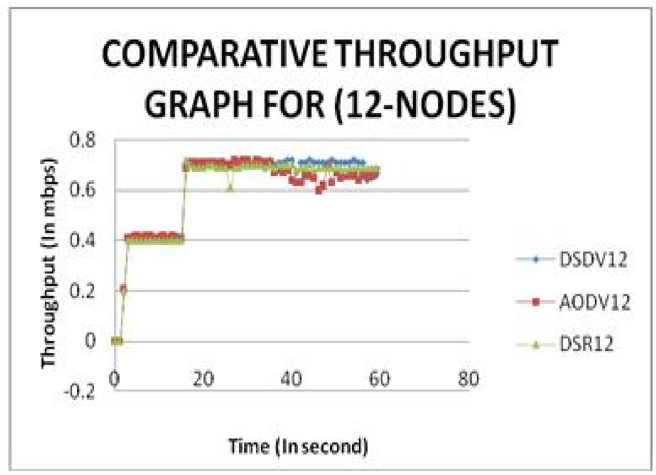

Fig.4. Throughput Comparison for 12-nodes

Throughput is the amount of data per unit time that is delivered from one node to another node via communication link. The throughput is measured in bits/second. Efficient routing protocols must have a greater throughput. Fig.2, Fig.3 and Fig.4 shows that, the throughput of DSR is better than 'AODV and DSDV' for 4-nodes, 8-nodes and 12-nodes scenario.

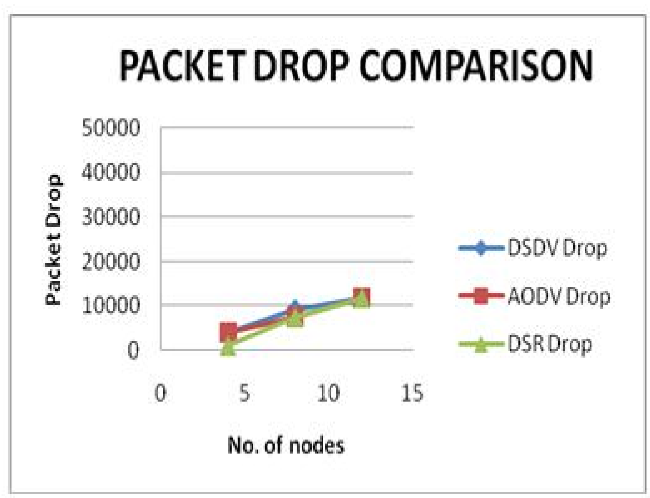

Fig.5. Packet Drop Comparison for DSDV, AODV and DSR

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A packet is dropped in two cases: the buffer is full when the packet needs to be buffer and the time that packets have been buffer exceeds the limit. Packet drop comparison graph show in fig.5. The packet drop for DSDV is maximum, DSR is minimum and AODV is between the DSDV and DSR 'for 4-nodes, 8-nodes and 12-nodes' scenario.

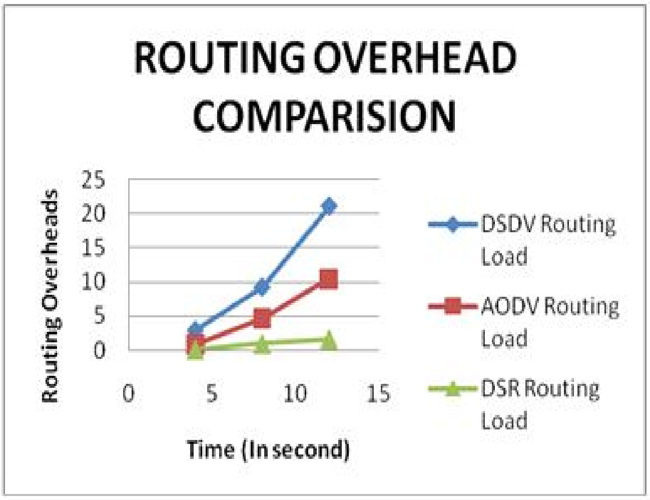

Fig.6. Routing overheads for DSDV, AODV and DSR

Routing overheads comparison graph shown in fig.6. The Routing overheads of DSDV is maximum, DSR is minimum and AODV is between the DSDV and DSR for all the cases of '4-nodes, 8-nodes and 12-nodes' scenario.

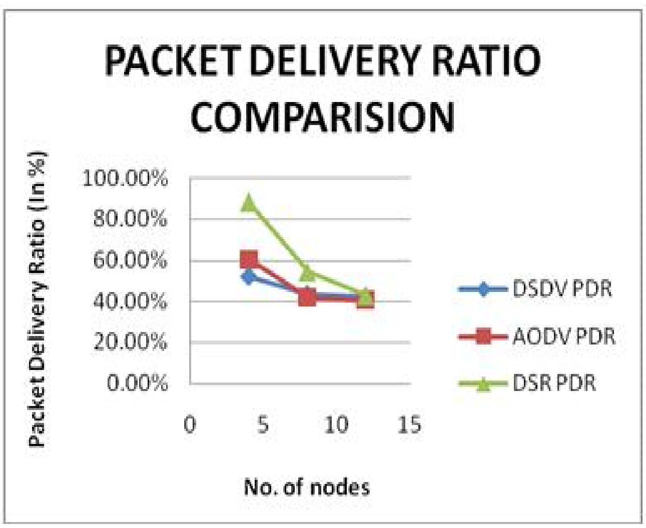

Fig.7. Packet Delivery Ratio Comparisons for DSDV, AODV and DSR

The Packet delivery ratio is expressed as the percentage of number of received packets by the destination node to the number of packets sent by the source node with in the period of simulation time. It is an essential performance metrics of routing protocols. According to simulation results the packet Packet delivery ratio of DSR is maximum, DSDV is minimum and AODV is between the DSDV and DSR for '4-nodes, 8-nodes and 12-nodes' scenario as shown in fig.9.

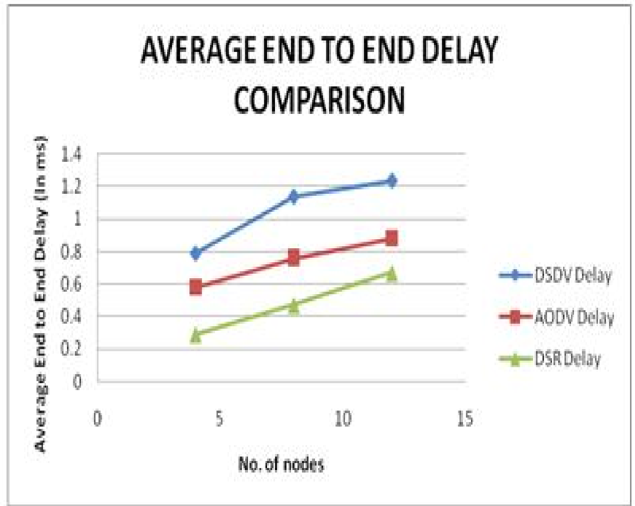

Fig.8. Average end to end delay for DSDV, AODV and DSR

Average end to end delay comparison graph shown in fig.8. Average end to end delay of DSDV is maximum, DSR is minimum and AODV is between the DSDV and DSR for '4-nodes, 8-nodes and 12-nodes' scenario.

CONCLUSION

In this paper, the performance evaluation of DSDV, AODV and DSR routing protocols is done through the simulation tool NS2 which gives the knowledge how to use routing schemes in dynamic network. Simulation results show that, as the number of nodes increases in the network, the performance of routing protocols decreases. In the above simulation results:

'Comparative throughput graphs' show that, the DSR throughput is better than 'DSDV and AODV' for '4-nodes, 8-nodes and 12-nodes' scenario. 'Comparative Graph for packet drop' shows that, the packet drop for the DSDV is maximum, DSR is minimum and AODV is between the DSDV and DSR for '4-nodes, 8-nodes and 12-nodes' scenario.

'Comparative Graph for routing overheads' shows that, the DSDV has maximum routing overheads, DSR has minimum routing overheads and AODV is between the DSDV and DSR for '4-nodes, 8-nodes, 12-nodes. 'Comparative graph for packet delivery ratio' shows that, DSR provides highest packet delivery ratio, DSDV provides lowest packet delivery ratio and AODV is between the DSDV and DSR for cases of '4-nodes, 8-nodes and 12-nodes' scenario.

'Comparative graph for average end to end delay' shows that, the DSR has minimum average end to end delay, DSDV has maximum average end to end delay and AODV is between the DSR and DSDV for '4-nodes, 8-nodes and 12-nodes' scenario. In the analyzed scenario, it is found that, the DSR is performing better than AODV and DSDV in all the cases of '4-nodes, 8-nodes, and 12 nodes, scenario.

DOI: 01.IJNS.03.01.113

References

[1] David B. Johnson and David A. Maltz. Dynamic source "Routing in ad hoc wireless networks" *Technical repor*t, Carnegie Mellon University, 1996.

[2] Mehran Abolhasan, Tadeusz Wysocki and Eryk Dutkiewicz. "A review of routing protocols for mobile ad hoc networks" *Technical report, Telecommunication and Information Research Institute, University of Wollongong, Wollong, NSW 2522. Motorola Australia Research Centre, 12 Lord St., Botany,* NSW 2525, Australia, 2003.

[3] Azzedine Boukerche "Algorithm and Protocols for wireless and Mobile Ad-hoc networks".

[4] Integration of mobile ad-hoc networks, EU project DAIDALOS, Susana Sargento, and Institute of Telecommunications.

[5] C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks, Architectures and Protocols", Second Edition, Low price Edition, Pearson Education, 2007.

[6] Mobile Ad Hoc Networking: An Essential Technology for Pervasive Computing Jun-Zhao *Sun MediaTeam, Machine Vision and Media Processing Unit, 2002.*

[7] Jun-Zhao Sun "Mobile Ad Hoc Networking: An Essential Technology for Pervasive Computing" USA 2003.

[8] G. S. Mamatha1 and Dr. S. C. Sharma, "ANALYZING THE MANET VARIATIONS, CHALLENGES, CAPACITY ANDPROTOCOL ISSUES", *"International Journal of Computer Science & Engineering Survey (IJCSES) Vol.1, No.1,* August 2010"

[9] Nor Surayati Mohamad, Usop Azizol Abdullah, Ahmad Faisal and Amri Abidin, "Performance Evaluation of AODV, DSDV & DSR Routing Protocol in Grid Environment, *"IJCSNS International Journal of Computer Science and Network Security,* VOL.9 No.7, July 2009.

[10] Zygmunt J. Haas, Jing Deng, Ben Liang, Panagiotis Papadimitratos, and S. Sajama, "Wireless Ad Hoc Networks" *Cornell University School of Electrical and Computer Engineering, 2004.*

[11] Elizabeth M. Royer and Chai-Keong Toh, "A review of current routing protocols for ad-hoc mobile wireless networks" *Technical report, University of California and Georgia Institute of Technology,* USA, 1999.

[12] C.E. Perkins and E.M. Royer, "Ad-hoc on Demand Distance Vector Routing Protocols", *in proceeded 2nd IEEE work shop mobile computing system and applications,* new ore leans, Loss Angelis, pp 90-100, February 2011.

[13] Md Shohidul Islam, Md Naim Hider, Md. Touhidul Haque, Leton miah "An Extensive Comparison among DSDV, DSR and AODV Protocols in MANET, *"International journal of computer application (0975-8887) Volume 15-no.2,* February 2011.

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